IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Sandhu et al.	§	Group Art Unit:	1763
		§		
		§		
		§	Examiner:	T. Dang
Serial No:	09/439,314	§		
		§	Atty. Docket:	95-0392.02
Filed:	November 12, 1999	§		
		§		
For: DEVICE FOR IN-SITU CLEANING OF AN INDUCTIVELY-COUPLED PLASMA CHAMBER		§		

APPLICANTS' BRIEF ON APPEAL

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Susan Jerome
Signature

Charles B. Brantley II, Reg. No. 38,086
Micron Technology, Inc.
8000 S. Federal Way
Mail Stop -25
Boise, ID 83716-9632
(208) 368-4557

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APPLICANTS' BRIEF ON APPEAL

I. REAL PARTY IN INTEREST

The Applicants, Gurtej S. Sandhu and Sujit Sharan, have assigned their interest in this application to Micron Technology, Inc.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to the Applicants or the assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF THE CLAIMS

Claims 1-69 have been presented during prosecution of the application under appeal.

Claims 1-40 have been canceled.

Claims 41-69 are pending.

Claims 41-69 are rejected under 35 U.S.C. §102 as being anticipated by Kumagai (U.S. Patent No. 5,916,455).

Claims 41-69 are appealed.

IV. STATUS OF THE AMENDMENTS

Applicants filed no amendments subsequent to final rejection.

V. SUMMARY OF THE INVENTION

The current invention addresses a device for *in-situ* cleaning of an inductively coupled plasma chamber. One exemplary embodiment concerns a semiconductor fabrication system comprising a reaction device that is configured to inductively generate a plasma. (Specification

at p. 7, ln. 19 – p. 8, ln. 2; FIG. 1.) The plasma, in turn, comprises an induction blocker, and the reaction device is configured to accept that induction blocker in an area that blocks plasma induction. (***Id***. at p. 4, ln. 3-11; p. 8, ln. 8 – p.9, ln. 14.) The semiconductor fabrication system further comprises a component that is coupled to the reaction device and that is configured to provide the reaction device with an induction blocker remover. (***Id***. at p. 9, ln. 5 – p. 10, ln. 14.) In a preferred exemplary embodiment, the component is a second reaction device that is configured to generate a second plasma comprising the induction blocker remover. (***Id***. at p. 9, ln. 19 – p. 10, ln. 5.)

In another exemplary embodiment, a wafer processing system comprises a reactor having a wafer fabrication mode and a reactor cleaning mode. (***Id***. at p. 7, ln. 19-28; p. 9, ln. 8-17; FIG. 1.) In the wafer fabrication mode, the reactor is configured to receive a metal-containing gas and further configured to locally generate a plasma. (***Id***. at p. 9, ln. 8-14.) In the reactor cleaning mode, the reactor is configured to receive a metal etchant and further configured to refrain from locally generating a plasma. (***Id***. at p. 9, ln. 19 – p. 10, ln. 7; *see also* p. 4, ln. 3-11 and p. 9, ln. 16 (disclosing the blocking of power coupling).) In a more specific exemplary embodiment of this type, the reactor interior is free of any wafer during the cleaning mode (***id***. at p. 9, ln. 14-16), and the metal etchant is transmitted in a non-plasma form during that mode (***id***. at p. 10, ln. 4-14).

Other exemplary embodiments of the current invention address a plasma processing system, a furnace assembly, a cleaning apparatus, a metal processing system, a plasma generation system, and a furnace assembly.

VI. ISSUE

There is one issue for determination on appeal: whether the Kumagai reference, as applied by the Examiner, is insufficient to anticipate the claimed invention.

VII. GROUPING

Applicants define the following group of claims for consideration upon this appeal. This group corresponds to the issue listed above.

Group I: claims 41-69 (the claims do not necessarily fall together).

VIII. ARGUMENT: The Kumagai reference, as applied by the Examiner, is insufficient to anticipate the claimed invention.

The Examiner rejected claims 41-69 as being anticipated by Kumagai (U.S.Patent No. 5,916,455). Applicants contend that Kumagai, as applied by the Examiner, fails to disclose all limitations in the claims, thereby warranting the Board's reversal of these rejections. Moreover, as discussed in detail below, different lapses in Kumagai's disclosure and the Examiner's argument apply to different claims. Hence, the claims do not necessarily fall together.

Claim 41, for example, requires a second chamber that is configured to initially generate a second plasma therein and further configured to lose an ability to generate that second plasma. Moreover, the second chamber is configured to receive another plasma that is configured to restore the ability of the second chamber to generate the second plasma. Kumagai discloses no such chamber configuration. The only Kumaigai chambers identified by the Examiner are the plasma ignition device (element 30) and vacuum chamber (element 11). However, Kumagai configures neither of those chambers to lose the ability to generate plasma. Kumagai in fact discloses only the exact opposite – with both chambers configured to always be ready to generate plasma. (*See* Kumagai at col. 2, ln. 20-28; col. 2, ln. 40-43; col. 5, ln. 5-7; col. 6, ln. 15-19.) If Kumagai's plasma ignition device were configured to lose the ability to generate plasma, the whole purpose of Kumagai's invention would be defeated. (***Id***. (indicating that the plasma ignition device provides a seed plasma that helps the vacuum chamber generate its own plasma); *see also* Abstract.) Kumagai goes even further in addressing its vacuum chamber, warning that it is configured to generate too strong a plasma that risks etching the chamber walls. (***Id***. at col. 1, ln. 41-47.) In disclosing only the exact opposite of a limitation in claim 41, Kumagai cannot be read as anticipating that claim or its dependent claims 42-44.

Moreover, dependent claim 42 contains an additional limitation concernig the second chamber's configuration in terms of the loss of the ability to generate a second plasma. Specifically, claim 42 requires that the second chamber be configured to lose the ability to generate the second plasma in response to a generation of that plasma. Claim 42 also requires that the second chamber be configured to regain the ability in response to a reception of another plasma. As Kumagai fails to disclose the broad configuration addressed in independent claim 41, Kumagai necessarily fails to disclose the narrower configuration specified in claim 42 and its dependent claims 43-44.

Claim 45 requires a structure, at least a part of which is transparent to a radio frequency wave, wherein the structure is configured to receive a material that is opaque to that wave, and wherein the structure is configured to interpose between a source of the wave and the material. If Kumagai disclosed such a configuration, then Kumagai's invention would be unable to induce plasma formation at some point. Kumagai, however, suggests that its relevant structures are always ready to induce plasma formation (*see* Kumagai at col. 2, ln. 20-28; col. 2, ln. 40-43; col. 5, ln. 5-7; col. 6, ln. 15-19) and, in fact, that one of Kumagai's chambers may induce plasma formation to an undesirable degree (***id***. at col. 1, ln. 41-47). Hence, Kumagai discloses only the exact opposite of the structural limitations of claim 45 and therefore cannot be understood to anticipate that claim and its dependent claims 46-49.

In addition, dependent claim 47 further requires a delivery system configured to deliver a material selected from a particular group. Kumagai fails to disclose a delivery system configured to deliver a material from that group. As a result, Kumagai further fails to anticipate claim 47 and its dependent claims 48 and 49. Moreover, claim 48 requires that the delivery system be configured to deliver a halogen. As Kumagai fails to disclose the broad configuration addressed in claim 47, Kumagai necessarily fails to disclose the narrower configuration specified in claim 48 and its dependent claim 49. Further, claim 49 requires an even narrower configuration, wherein the delivery system is configured to deliver a polyhalogen. Accordingly, Kumugai fails to disclose this limitation as well.

Claim 50 requires a device that is configured to inductively generate a plasma, wherein the plasma comprises an induction blocker, and wherein the device is configured to accept the induction blocker in an area that blocks plasma induction. The Examiner assumed that Kumagai's invention is configured to inductively generate a plasma comprising an induction

blocker. However, the Examiner did not cite where Kumagai discloses such a configuration, thereby indicating a failure to meet the *prima facie* burden for rejection. Further, the Examiner failed to address claim 50's limitation that the device be configured to accept the induction blocker in an area that blocks plasma induction. The Examiner's failure to do so is further indication that the *prima facie* burden for rejection has not been met. Moreover, the fact that both of Kumagai's chambers appear ready at all times to induce plasma suggests that the *prima facie* burden for rejecting claim 50 cannot be met relying on Kumagai, as that reference discloses only the exact opposite of that limitation. (*See* Kumagai at col. 2, ln. 20-28; col. 2, ln. 40-43; col. 5, ln. 5-7; col. 6, ln. 15-19.) Dependent claims 51-53 benefit accordingly.

Moreover, dependent claim 52 further qualifies the configuration requirements of claim 50's device, requiring that the device comprise a quartz component that is configured to accept the induction blocker thereon. As Kumagai fails to disclose the broad configuration addressed in claim 50, Kumagai necessarily fails to disclose the narrower configuration specified in claim 52 and its dependent claim 53.

Claim 54 concerns a cleaning apparatus for an inductively-coupled plasma chamber, comprising a cleaning chamber that is configured to provide a metal-cleaning gas to the plasma chamber. Applicants assert that neither of Kumagai's chambers cited by the Examiner disclose all of claim 54's requirements for the cleaning chamber. Kumagai's plasma ignition device is not configured to provide a metal-cleaning gas. Rather, Kunagai's plasma ignition device is configured to provide an inert plasma-generating gas. (Kumagai at col. 2, ln. 17-19; col, 4, ln. 1-col. 5, ln. 7.) Any attempt to analogize Kumagai's plasma-generating gas to a cleaning gas, let alone a metal-cleaning gas, is questionable given that Kumagai also teaches providing a discrete etching gas from elsewhere. (***Id***. at col. 3, ln. 29-31; col. 5, ln. 8-15.) As for Kumagai's vacuum chamber, it is not configured to provide a metal cleaning gas to another plasma chamber. Hence, it, too, fails to address all of claim 54's limitations. These limitations are incorporated into dependent claims 55 and 56, each of which contain additional limitations concerning the cleaning chamber, thereby further emphasizing their novelty.

Claim 57 requires a reactor having a reactor cleaning mode as well as a wafer fabrication mode. Each of that claim and its dependent claims 58-59 express limitations concerning the reactor cleaning mode. Kumagai, however, makes no mention of cleaning a reactor. Rather, Kumagai's disclosure is focused on modes concerning wafer fabrication. (Kumagai at col. 1, ln.

12-23; col. 1, ln. 39-40; col. 1, ln. 43-44; col. 3, ln. 11; col. 5, ln. 37-41; *see also* col. 6, ln. 29-35 (referring to "the object to be processed" and the "intended product"); FIG. 1.) As a result, Kumagai fails to anticipate the limitations in claims 57-59 that address a reactor cleaning mode. Moreover, claim 57 further requires that the reactor be configured to refrain from locally generating a plasma during this mode. On the other hand, all of the cited Kumagai chambers are configured to generate a local plasma in any mode disclosed by Kumagai. (***Id.*** at col. 2, ln. 20-28; col. 2, ln. 40-43; col. 5, ln. 5-7; col. 6, ln. 15-19.) As a result, Kumagai teaches only the exact opposite of this limitation; and such diametrically opposed teachings cannot be read to anticipate claim 57 and its dependent claims 58-59.

Moreover, dependent claims 58 and 59 contain additional limitations on the reactor cleaning mode that are in direct contradiction with Kumagai's disclosure. Claim 58, for example, requires that the reactor interior be free of any wafer during the reactor cleaning mode. Because Kumagai's disclosed modes require a wafer (Kumagai at col. 1, ln. 12-23; col. 1, ln. 39-40; col. 1, ln. 43-44; col. 3, ln. 11; col. 5, ln. 37-41; col. 6, ln. 29-35; FIG. 1), Kumagai necessarily fails to disclose this limitation expressed in claim 58 and incorporated into dependent claim 59. Moreover, claim 59 requires that a chamber configured to couple to the reactor be further configured to transmit a metal etchant *in a non-plasma form* to the reactor during the cleaning mode. Because Kumagai's disclosed modes require plasma generation (***id.*** at col. 2, ln. 20-28; col. 2, ln. 40-43; col. 5, ln. 5-7; col. 6, ln. 15-19), Kumagai necessarily fails to disclose this limitation as well.

Although the Examiner purported to reject all of the pending claims in the latest Office Action (dated 5/22/01), the Examiner failed to particularly address claims 60-69, instead relying on an almost verbatim argument as the one presented in the previous Office Action (dated 8/30/00). Significantly, the Examiner did so even after Applicants pointed out a similar failure to address claims 60-62. (First Amendment and Response mailed 2/28/01 at 3.) Applicants contend that the Examiner's continued lapse constitutes a failure to meet the *prima facie* burden for rejecting claims 60-69. In addition, these claims contain limitations that Kumagai fails to disclose.

Claim 60, for example, requires a furnace comprising a quartz tube. Claim 60 additionally requires that the furnace be configured to allow the deposition of a metal on the quartz tube and on a wafer located inside the tube. Assuming the Examiner intended to

analogize one of Kumagai's cited chambers to the furnace, Applicants note that both of those chambers fail to disclose all of the requirements for claim 60's furnace. The only time Kumagai mentions quartz is in discussing its ignition device (30). (Kumagai at col. 3, ln. 50-56.) That device, however, is disclosed as housing inert gas. (***Id.*** at col. 4, ln. 23-28.) Hence, Kumagai's ignition device is not configured to allow metal deposition thereon. Furthermore, Kumagai configures its ignition device to be remote from the wafer. (***Id.*** at FIG. 1&2.) As a result, Kumagai discloses the exact opposite of claim 60's furnace configuration concerning a wafer located inside the quartz tube. As for Kumagai's vacuum chamber (10), Kumaugai fails to disclose that it comprises a quartz tube. Further, Kumagai seeks to avoid depostion on its vacuum chamber surface (***id.*** at col. 6, ln. 29-32) and hence cannot be read to disclose being configured to allow the deposition of a metal thereon. As a result, Kumagai is either silent or discloses only the exact opposite of the limitations claim 60's furnace. In doing so, Kumagai cannot be read to anticipate claim 60. Similar problems arise in attempts to analogize either of Kumagai's chambers to claim 60's cleaning chamber. These distinguishing limitations support the novelty of claim 60 as well as its dependent claims 61 and 62.

In addition, dependent claims 61 and 62 express still other distinguishing limitations. Claim 61, for example, requires that the furnace be configured to allow gas to access to the quartz tube to the exclusion of the wafer. In addition to the problems faced with attempting to analogize any of Kumagai's elements to the quartz tube, all of Kumagai's configurations involve the inclusion of a wafer. (Kumagai at col. 1, ln. 12-23; col. 1, ln. 39-40; col. 1, ln. 43-44; col. 3, ln. 11; col. 5, ln. 37-41; col. 6, ln. 29-35; FIG. 1.) Because Kumagai's disclosure is in direct opposition to the limitation expressed in claim 61 and incorporated in claim 62, Kumagai cannot be interpreted as anticipating those claims. Similarly, claim 62 requires that the furnace be configured to allow gas to access to the quartz tube in response to removal of the wafer from the furnace. Again, Kumagai's configurations, wherein a wafer is present in all such configurations (***id.***), disclose only the exact opposite of this limitation and therefore cannot anticipate the claim.

Claim 63 requires a conductive material that is present between a chamber's process area and its plasma inducer after the chamber's deposition mode. Kumagai, on the other hand, discloses only the exact opposite by addressing only modes wherein both of the cited chambers are ready to generate plasma. (*See* Kumagai at col. 2, ln. 20-28; col. 2, ln. 40-43; col. 5, ln. 5-7; col. 6, ln. 15-19.) The opposing nature of Kumagai's disclosure is further bolstered by its

indication that only a plasma-generation gas appears in its ignition device (***id.*** at col. 2, ln. 17-19; col, 4, ln. 1- col. 5, ln. 7) and that deposition on the vacuum chamber's surface is discouraged (***id.*** at col. 6, ln. 29-32). Kumagai's disclosure being in direct opposition to the limitations of claim 63 results in Kumagai's failure to anticipate that claim and its dependent claims 64-66. Moreover, each of dependent claims 64-66 express additional limitations on the conductive material required by claim 63. Hence, their novelty is even further supported.

Claim 67 requires a structure that defines a furnace interior and is configured to interpose between a source of energy and a material that is opaque to that energy. Given that all of Kumagai's configurations concern chambers that are always ready to generate plasma (Kumagai at col. 2, ln. 20-28; col. 2, ln. 40-43; col. 5, ln. 5-7; col. 6, ln. 15-19), Kumagai's disclosure is in direct opposition to this limitation and therefore fails to anticipate this claim and its dependent claims 68 and 69.

The Examiner has previously argued that at least some of the claims appeared to contain language that was related to the use of the claimed apparatus. The Examiner concluded that such language did not distinguish the structure of the claimed apparatus from that of Kumagai. Applicants contend that the above statements address (1) the structural limitations of the claims and (2) how Kumigai's disclosure either fails to address or addresses only structures that are in direct opposition to the claims' structural limitations. Accordingly, Applicants request that the Board reverse the Examiner's novelty rejections based on Kumagai.

Respectfully submitted,

Charles Brantley
6/15/01

Charles Brantley
Registration No. 38,086
Micron Technology, Inc.
8000 S. Federal Way
Boise, ID 83716-9632
(208) 368-4557
Attorney for Applicants

Appendix I: Copy of Involved Claims

41. A plasma processing system, comprising:

a first chamber configured to generate a first plasma therein; and

a second chamber coupled to said first chamber, wherein said second chamber is configured to initially generate a second plasma therein, further configured to lose an ability to generate said second plasma, and configured to receive said first plasma, wherein said first plasma is configured to restore said ability.

42. The system in claim 41, wherein said second chamber is configured to lose said ability in response to a generation of said second plasma, and further configured to regain said ability in response to a reception of said first plasma.

43. The system in claim 42, wherein said second chamber is a tube furnace.

44. The system in claim 43, wherein said first chamber is a tube furnace.

45. A furnace assembly, comprising:

a structure defining a furnace interior, wherein at least a part of said structure is transparent to a radio-frequency wave, wherein said structure is configured to receive a first material that is opaque to said wave, and wherein said structure is configured to interpose between a source of said wave and said first material; and

a delivery system in fluid communication with said interior defined by said structure,

said system configured to deliver a second material to said first material, wherein said second material is reactable with said first material.

46. The furnace assembly in claim 45, wherein said delivery system is configured to deliver an etchant.

47. The furnace assembly in claim 46, wherein said delivery system is configured to deliver a second material selected from a group comprising fluorine, chlorine, bromine, hydrogen chloride, hydrogen fluoride, hydrogen bromide, sulphur hexafluoride, nitrogen trifluoride, carbon tetrachloride (CCl_4), carbon tetrafluoride (CF_4), chlorine monofluoride (ClF), chlorine trifluoride (ClF_3), bromine chloride ($BrCl$), bromine monofluoride (BrF), bromine trifluoride (BrF_3), bromine pentafluoride (BrF_5), iodine monobromide (IBr), iodine tribromide (IBr_3), iodine monochloride (ICl; alpha and beta), iodine trichloride (ICl_3), iodine pentafluoride (IF_5), iodine heptafluoride (IF_7), carbon dichlorodifluoride (CCl_2F_2), and NF_3.

48. The furnace assembly in claim 46, wherein said delivery system is configured to deliver a halogen.

49. The furnace assembly in claim 48, wherein said delivery system is configured to deliver a polyhalogen.

50. A semiconductor fabrication system, comprising:

a first reaction device configured to inductively generate a first plasma, wherein said first

plasma comprises an induction blocker, and wherein said first reaction device is further configured to accept said induction blocker in an area that blocks plasma induction; and

a component coupled to said first reaction device and configured to provide said first reaction device with an induction blocker remover.

51. The semiconductor fabrication system in claim 50, wherein said component is a second reaction device configured to generate a second plasma comprising said induction blocker remover.

52. The semiconductor fabrication system in claim 51, wherein said first reaction device comprises a quartz component having an interior defining a plasma induction region; and wherein said quartz component is configured to accept said induction blocker thereon.

53. The semiconductor fabrication system in claim 52, wherein said second reaction device is configured to generate a second plasma comprising a conductive material remover.

54. A cleaning apparatus for an inductively-coupled plasma chamber, comprising:

a conduit configured to couple to said inductively-coupled plasma chamber; and

a cleaning chamber coupled to said conduit and configured to provide a metal-cleaning gas to said inductively-coupled plasma chamber through said conduit.

55. The cleaning apparatus of claim 54, further comprising a plasma-generation device around said cleaning chamber, wherein said plasma-generation device is configured to inductively generate a metal-etching plasma within said cleaning chamber.

56. The cleaning apparatus in claim 55, wherein said cleaning chamber is configured to provide said metal-etching plasma to said inductively-coupled plasma chamber through said conduit.

57. A wafer processing system, comprising:

a reactor having a wafer fabrication mode and a reactor cleaning mode, wherein said reactor is configured to receive a metal-containing gas during said wafer fabrication mode, locally generate a plasma during said wafer fabrication mode, receive a metal etchant during said reactor cleaning mode, and refrain from locally generating a plasma during said reactor cleaning mode; and

a chamber configured to couple to said reactor during said reactor cleaning mode and further configured to temporarily house said metal etchant.

58. The system in claim 57, wherein an interior of said reactor is free of any wafer during said reactor cleaning mode.

59. The system in claim 58, wherein said chamber is configured to transmit said metal etchant in a non-plasma form to said reactor during said cleaning mode.

60. A metal processing system, comprising:

a furnace comprising a quartz tube and configured to house a high-density plasma and to allow deposition of a metal on said quartz tube and on a wafer located inside said quartz tube; and

a cleaning chamber coupled to said furnace and configured to house a gas that is configured to etch said metal from said quartz tube.

61. The system in claim 60, wherein said furnace is configured to allow said gas to access said quartz tube to the exclusion of said wafer.

62. The system in claim 61, wherein said furnace is configured to allow said gas to access said quartz tube in response to a removal of said wafer from said furnace.

63. A plasma-generation system, comprising:

a first plasma chamber;

a second plasma chamber having a deposition mode and a cleaning mode, wherein said second plasma chamber comprises:

a housing defining a process area and coupled to said first plasma chamber, and

a plasma inducer around said housing; and

a conductive material present after said deposition mode between said process area and said inducer.

64. The system in claim 63, wherein said conductive material is between said process area and said housing.

65. The method in claim 64, wherein said conductive material is absent after said cleaning mode.

66. The method in claim 65, wherein said conductive material is absent before said deposition mode.

67. A furnace assembly, comprising:

a first material that is opaque to a type of energy;

a structure defining a furnace interior, wherein at least a part of said structure is transparent to said energy, wherein said part contacts said first material, and wherein said structure is configured to interpose between a source of said energy and said first material; and

a plasma delivery system in fluid communication with said interior defined by said structure.

68. The assembly in claim 67, wherein said first material is present before said plasma delivery system is active.

69. The assembly in claim 68, wherein said first material is opaque to a radio-frequency wave.